HYDROGEOLOGIC CONDITIONS ALONG 15TH STREET, NEW ALBANY, INDIANA

Prepared for

Greenbaum Associates, Inc.
994 Longfield Avenue
Louisville, Kentucky 40215

Prepared by

Angelo I. George
A. I. George Consultants
1869 Trevilian Way
Louisville, KY 40205

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Respectfully submitted:

Angelo I. George
Consulting Geologist
American Institute of Professional Geologist, No. 4959
State of Indiana, No. 309

INTRODUCTION

An aging sewer system below 15th Street in New Albany, Indiana, is scheduled for replacement or refurbishing. A section of the sewer collapsed near the intersection of East Elm Street and 15th Street and has since been repaired. Unconsolidated lacustrine and glacial outwash sediments associated with a shallow ground water level needs to be addressed during construction. One could consider a network of dewatering wells to keep the excavation dry during construction. A review of the local geology, hydrology, location of high yield water wells, and test borings for lithology was made in partial preparation to design an aquifer pump test analysis of the formation. Data from the aquifer analysis provides the groundwork for the design of a network of dewatering wells.

The study area is defined as extending north along 15th Street from Division Street to Beeler Street. The CSX Railroad tracks are built down through the center of 15th along its complete length. The 24-inch diameter sewer is positioned about 12-15 feet below land-surface. A network of wells is needed to dewater the excavation to a depth of at least 17 feet below land surface. High static ground water level is positioned within unconsolidated formations that change character and ground water yield along the length of 15th Street.

The study area is located within a region called the Scottsburg Lowland of the Interior Low Plateau. The topographic feature extends south out of Indiana along the base of the Knobstone Escarpment into Jefferson County, Kentucky. Viewing the bedrock surface map (MacCary 1955), the locality takes on the configuration of "step-like" buried topography displayed as a structurally induced landform on Devonian black shales (Figure 1). The feature is filled with Pleistocene clays, silts, and sand, presenting a terrain of very low relief and poor drainage. Glacial blockage of streams draining into the Ohio River during the Pleistocene initiated lacustrine depositional conditions north from the river over this topographic feature.

Glaciofluvial and glaciolacustrine deposits have different ground water yielding properties (Figure 2). Unconsolidated sediments in the vicinity of New Albany consist of five different hydrostratigraphic units (Maier, 2006). Bordering the Ohio River is a narrow swath of sediments capable of supporting high yields water wells. This is called the Ohio River Outwash Aquifer, with well yields in the range of 250-1050 gpm. Progressing to the north, another hydrostratigraphic aquifer is known to produce well yields in the range of >180 gpm. This is the Ohio River Aquifer Subsystem. Further north is an areally extensive aquifer called the Alluvial, Lacustrine, and Backwater Aquifer. Well yields of less than 5 gpm are possible. The remainder of the county consists of the unglaciated southern hills and lowlands to include the Dissected Till and Residuum Aquifer System. Well yields are less than 5 gpm with numerous dry holes. Bedrock aquifers produce considerably more water than the unconsolidated overburden.

The proposed sewer excavation spans two of these hydrostratigraphic aquifers consisting of the Ohio River Aquifer Subsystem, and the Alluvial, Lacustrine, and Backwater Aquifer. Using the map by Meier along with existing or prior high yield water wells gives an idea as to what to expect during a dewatering project during construction of the sewer line. The ground water map suggests extraction rates of 180 gpm or more could be possible in some areas.

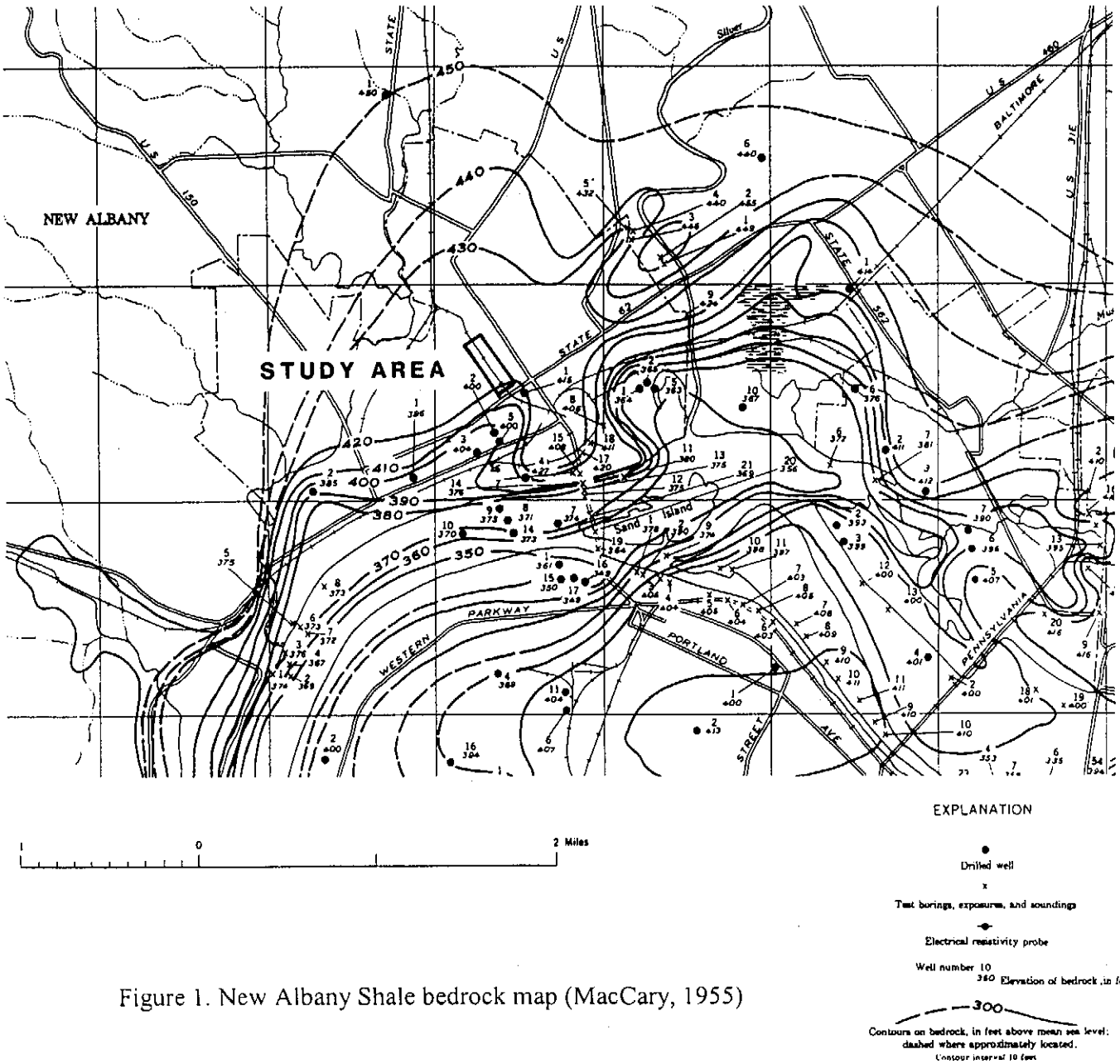


Figure 1. New Albany Shale bedrock map (MacCary, 1955)

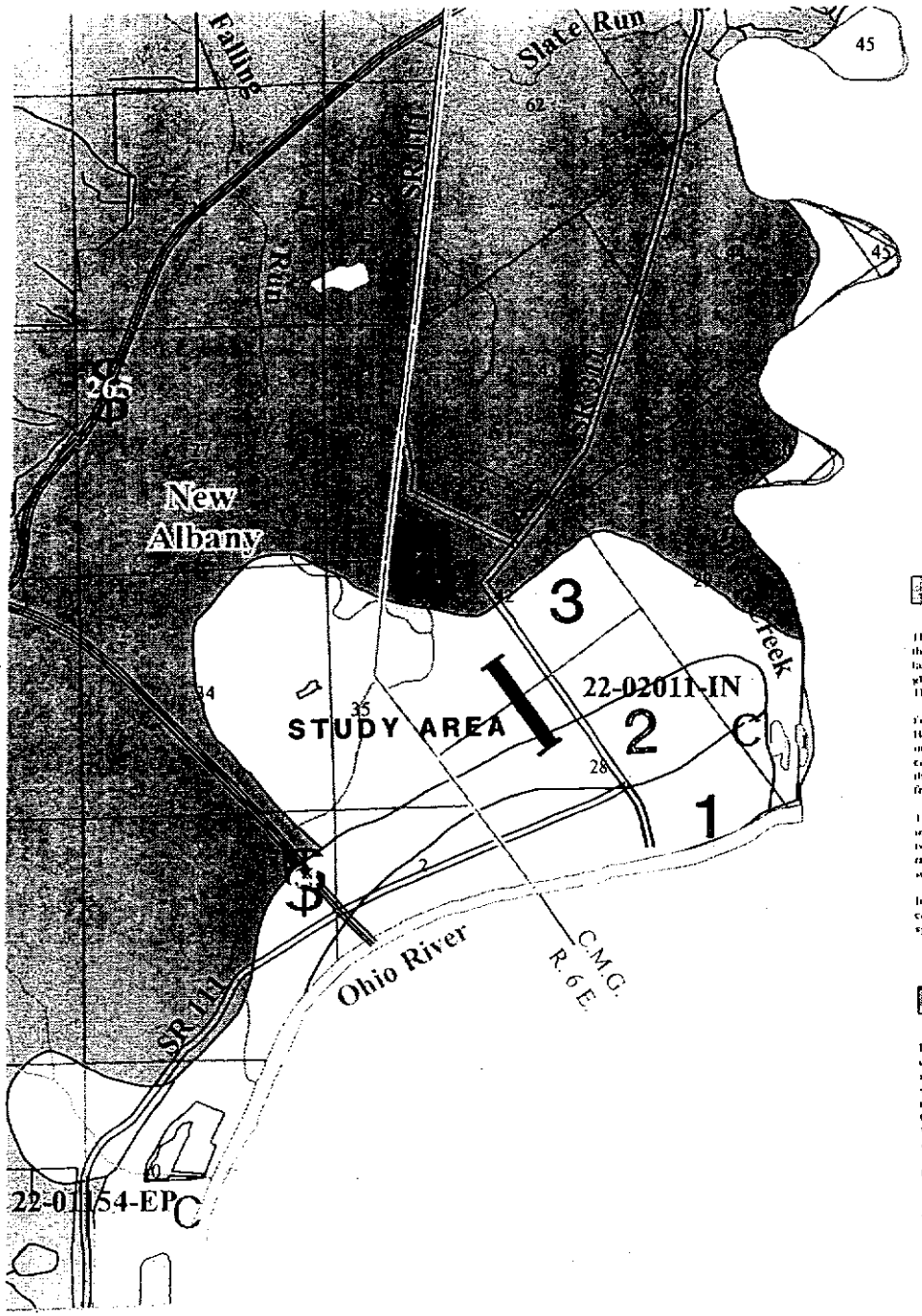


Figure 2. Ground water availability map of the New Albany vicinity, Indiana (after Maier, 2006).

Five unconsolidated aquifer systems are mapped in Floyd County: the Unglaciated Southern Hills and Lowlands; the Dissected Till and Residuum; the Alluvial, Lacustrine, and Backwater Deposits; the Ohio River Outwash; and the Ohio River Outwash Subsystem. Boundaries of these aquifer systems are commonly gradational, and individual aquifers may extend across aquifer system boundaries. However, in areas where the topography is steep, boundaries between aquifer systems are more distinct.

Thickness, type, and areal extent of unconsolidated deposits in Floyd County are variable. Thick deposits (up to 100 feet) of outwash, alluvial, and lacustrine sediments are confined to the Ohio River Valley and its tributaries. However, bedrock residuum extends across most of the county, with isolated areas of pre-Wisconsin glacial sediments (mainly along the eastern edge of the county). These sediments range from less than five feet (in areas where only residuum is present) to as much as 60 feet (where glacial drift is present).

Regional estimates of aquifer susceptibility to contamination from the surface can differ considerably from local reality. Variations within geologic environments can cause variation in susceptibility to surface contamination. In addition, man-made structures such as poorly constructed water wells, unplugged or improperly abandoned wells, and open excavations, can provide contaminant pathways that bypass the naturally protective clays.

Ohio River Outwash Aquifer System

The Ohio River Outwash Aquifer System in Floyd County is mapped along portions of the main valley of the Ohio River. Aggradation of the pre-glacial Ohio River Valley with large amounts of outwash sand and gravel from pre-Wisconsin and Wisconsin receding glaciers filled portions of the river valley. Recent alluviation continues to fill the valley. These outwash and alluvial deposits form the most prolific aquifer system in the county.

Few wells produce from the Ohio River Outwash Aquifer System in Floyd County. However, several test and production wells for the Edwardsville Water Corporation indicate unconsolidated thicknesses up to 100 feet in places with 70 to 100 feet of continuous sand and gravel. In some areas as much as 50 feet of sandy clay or silt overlie the aquifer materials. Thickness of saturated sands and gravels, however, generally ranges from 30 to 60 feet. Well depths are commonly 60 to 100 feet.

The Ohio River Outwash Aquifer System has the greatest potential of any aquifer system in Floyd County and can meet the needs of domestic and high-capacity users. There are two registered high-capacity facilities (5 wells) using this system. Reported well yields range from 250 to 1050 gpm with reported static water levels of 30 to 45 feet below surface.

In areas that lack overlying clays, this aquifer system is highly susceptible to contamination from surface sources. Where clay or silt deposits overlie the aquifer system, the aquifer is moderately susceptible to surface contamination.

Ohio River Outwash Aquifer Subsystem

In Floyd County, the Ohio River Outwash Aquifer Subsystem is mapped along a portion of the Ohio River and adjacent to the Ohio River Outwash System. In general, this system (subsystem) is mapped where the topographic position is higher and thickness of saturated outwash materials is considerably less than the main outwash system. Also, aquifer sand and gravels are generally overlain by greater thicknesses of silt, clay, or lacustrine deposits. In places, the system is also mapped along areas of the Ohio River Valley where depth to bedrock is significantly shallower than along the main outwash system in Floyd County.

Few water well records are available in the Ohio River Outwash Aquifer Subsystem. Total thickness of unconsolidated materials within this system ranges from about 25 to 80 feet with nearly 50 feet of continuous sand and gravel. Saturated sands and gravels generally range from 15 to 40 feet thick. The Ohio River Outwash Aquifer Subsystem has the potential to meet the needs of domestic and some high-capacity users. There is one registered high-capacity facility (2 wells) with reported yields of 1000 gpm each and static water levels of 25 to 30 feet below ground surface.

Alluvial, Lacustrine, and Backwater Deposits Aquifer System

The Alluvial, Lacustrine, and Backwater Deposits Aquifer System is mapped along portions of larger tributaries and floodplains of the Ohio River in Floyd County. These tributaries include: Indian Creek in the west-central portion of the county; to the south along Knob Creek; and to the east along Middle Creek and Silver Creek and a portion of New Albany.

This system consists of deposits that come from two primary sources. The first is alluvium deposited by streams along with colluvium eroded from valley walls and upland areas. The second is from pre-Wisconsin and Wisconsin fine-grained glacial-lacustrine deposits formed in relatively static lake waters. Typical materials include fine sand, silt, and clay deposits that are generally greater than 25 feet thick. Aquifer materials typically include thin sand seams that are generally less than 5 feet thick. However, two bedrock wells along Knob Creek indicate that sand deposits overlying bedrock are up to 60 feet thick.

The Alluvial, Lacustrine, and Backwater Deposits Aquifer System is a limited resource and no reported wells produce from these deposits. However, large diameter bored (bucket-rig) wells may be adequate to meet the needs of some domestic users. Typical well yields are expected to be less than 5 gpm with the potential of some dry holes.

Thick deposits of silt and clay that have a low susceptibility to surface contamination generally mark this aquifer system. The susceptibility is greater in areas where the surficial silt and clay deposits are thin and directly overlie outwash deposits.

Unglaciated Southern Hills and Lowlands Aquifer System / Dissected Till and Residuum Aquifer System

In Floyd County, the Unglaciated Southern Hills and Lowlands and the Dissected Till and Residuum Aquifer Systems are mapped as one system because they are similar in composition and in aquifer characteristics. The combined systems are mapped throughout most of the county and consist of either pre-Wisconsin till deposits of variable thickness with very thin interbedded layers of outwash sand and gravel (mainly along the eastern edge of Floyd County), or thin, eroded bedrock residuum. Together, they have the most limited ground-water resources of the unconsolidated aquifer systems mapped in the county.

Total thickness of these systems generally ranges from less than 5 feet (where only residuum is present) to about 60 feet in the eastern part of the county where isolated remnants of pre-Wisconsin till materials are present. Potential aquifer materials consist of thin sand and gravel deposits that are typically less than 3 feet thick.

There are no reported wells producing from the Unglaciated Southern Hills and Lowlands or the Dissected Till and Residuum Aquifer Systems in Floyd County. Because this aquifer system is generally thin and not very productive, wells are typically completed in the underlying bedrock aquifer system. However, large diameter bucket wells may be successful in meeting the needs of some domestic users. Typical well yields are expected to be less than 5 gallons per minute (gpm) with the potential of some dry holes. Because of the low permeability of the surface materials, these aquifer systems are not very susceptible to contamination from surface sources.

There is a small cluster of water wells in the vicinity of the proposed sewer excavation (Figure 3). Two are found along Main Street and produce discharges greater than 180 gpm. Yields decrease north of the intersection of Spring Street and Vincennes, yet have discharges in the range of 175 gpm (Rorabaugh et al., 1953). Gradationally, well yields decrease northward because of a change in depositional character of the unconsolidated formation.

Greenbaum Associates, Inc., drilled a number of test borings along 15th Street from Division Street on the south to Beeler Street on the north. Bracketed on the west by two borings on East 13th Street, and two to the east on Vincennes Street (Figure 4). In general, bedrock consists of the New Albany Shale. Stream erosion during the Wisconsin glacial advances and retreats eroded channels into this surface (Figure 4). Test drilling reveals variable depths and in one case, boring B6, penetrated 51.5 feet without intersecting the New Albany Shale. Close space borehole logs suggest the valley is very narrow, perhaps not more than 300 feet wide. Suspect it is part of a paleostream channel associated with Falling Run creek that carried glacial outwash melt waters from a receding glacier.

Strip lithologic logs (Figure 5) were placed side by side along the proposed 15th Street excavation. One can view the change in lithology from the south to the north. There is also a change in bedrock elevation to a more shallow depth toward the north, with the exception of B6. Lithology tends to become silty to the north and is an indication of backwater depositional condition.

Using the drilling logs and transposing the map by Maier (2006) indicates boring Nos. B14 through B11 are localized in the Ohio River Aquifer Subsystem. Borings Nos. B10 to B1 is in the Alluvial, Lacustrine, and Backwater Aquifer. From B8 to B1 the upper formation changes to a dominant clay-silt composition in the upper 15-16 feet. Interlaced with B5 to B4 changes back to more fine sand only to thicken with clay silt from B3 to B1 to bedrock. Note that the Ohio River Aquifer Subsystem extends further north than the map indicates (Figure 2). Ground water extraction rates will change depending upon which hydrostratigraphic aquifer is encountered.

AQUIFER PUMP TEST ANALYSIS

A dewatering plan calls for keeping an excavation dewatered to 17 feet below land surface. Wells will have to be employed for most of the proposed excavation except north of Shelby Street between boring B3 and B1 on Beeler Street. The aquifer pump test site was selected because it is in the middle of the swath for the proposed excavation.

National Water Services, Llc., of Paoli, Indiana, drilled two specialized wells near the northeast corner of 15th Street and Culbertson Avenue (Figure 4). The wells are on the east side of 15th Street in the grassy area next to the sidewalk. One is a 5¼-inch diameter well with 4-feet of 15-slot screen that was drilled to a depth of 32.5-feet. Only 25.5-feet could be used, because the basal part of the formation changed to 7-feet of blue clay till. Ten-feet to the north is a 2¼-inch diameter observation well drilled to a depth of 24-feet and fitted with 5-feet of 10-slot PVC screen. Both wells were set in-placed down through a flight of hollow stem augers and developed with high-pressure air and in addition a submersible pump was used in the larger diameter well. The larger diameter well screen

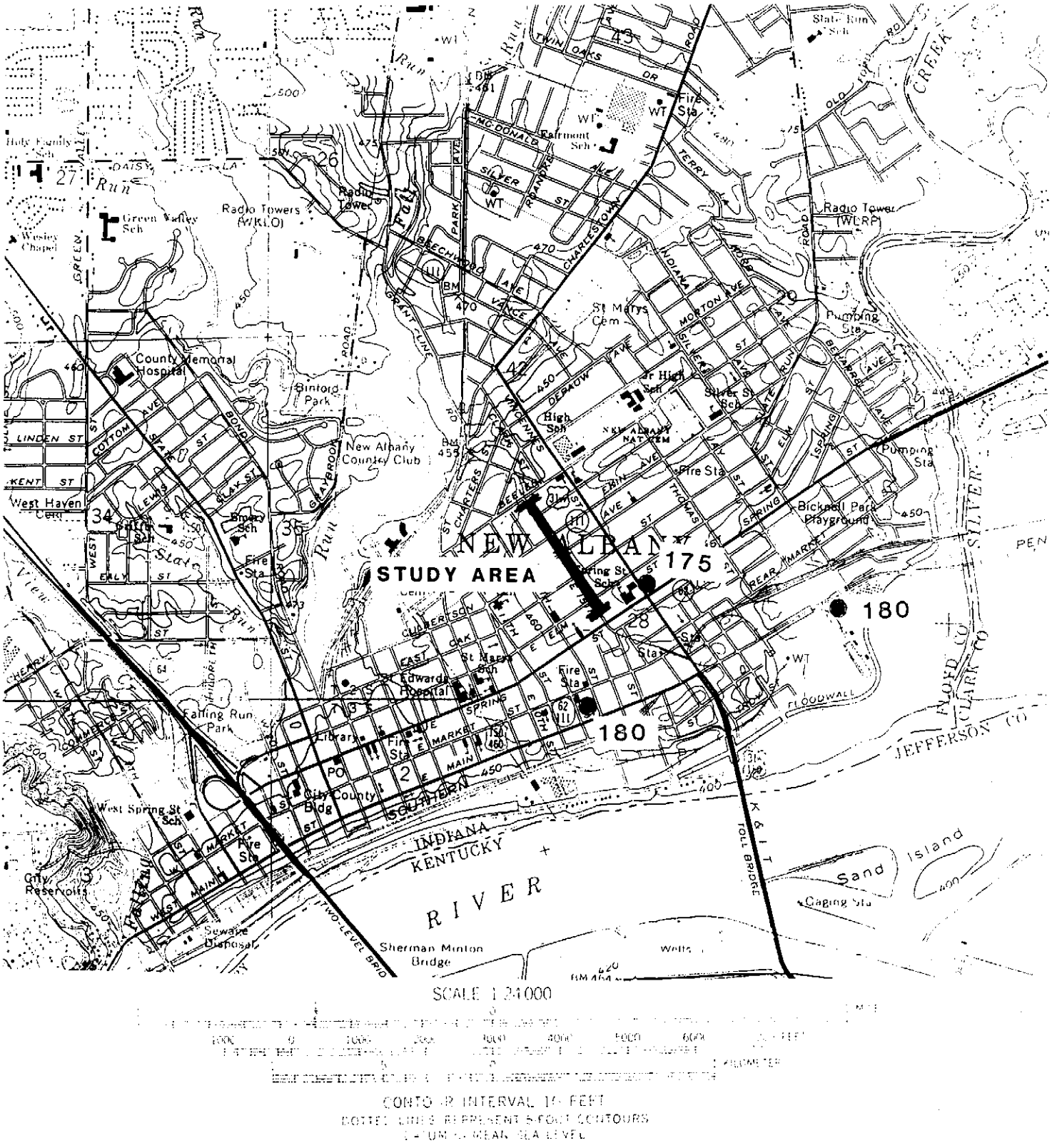


Figure 3. Contour map of a portion of the 7.5-minute New Albany Topographic Quadrangle, showing location of the Study Area, and known high yield water wells.

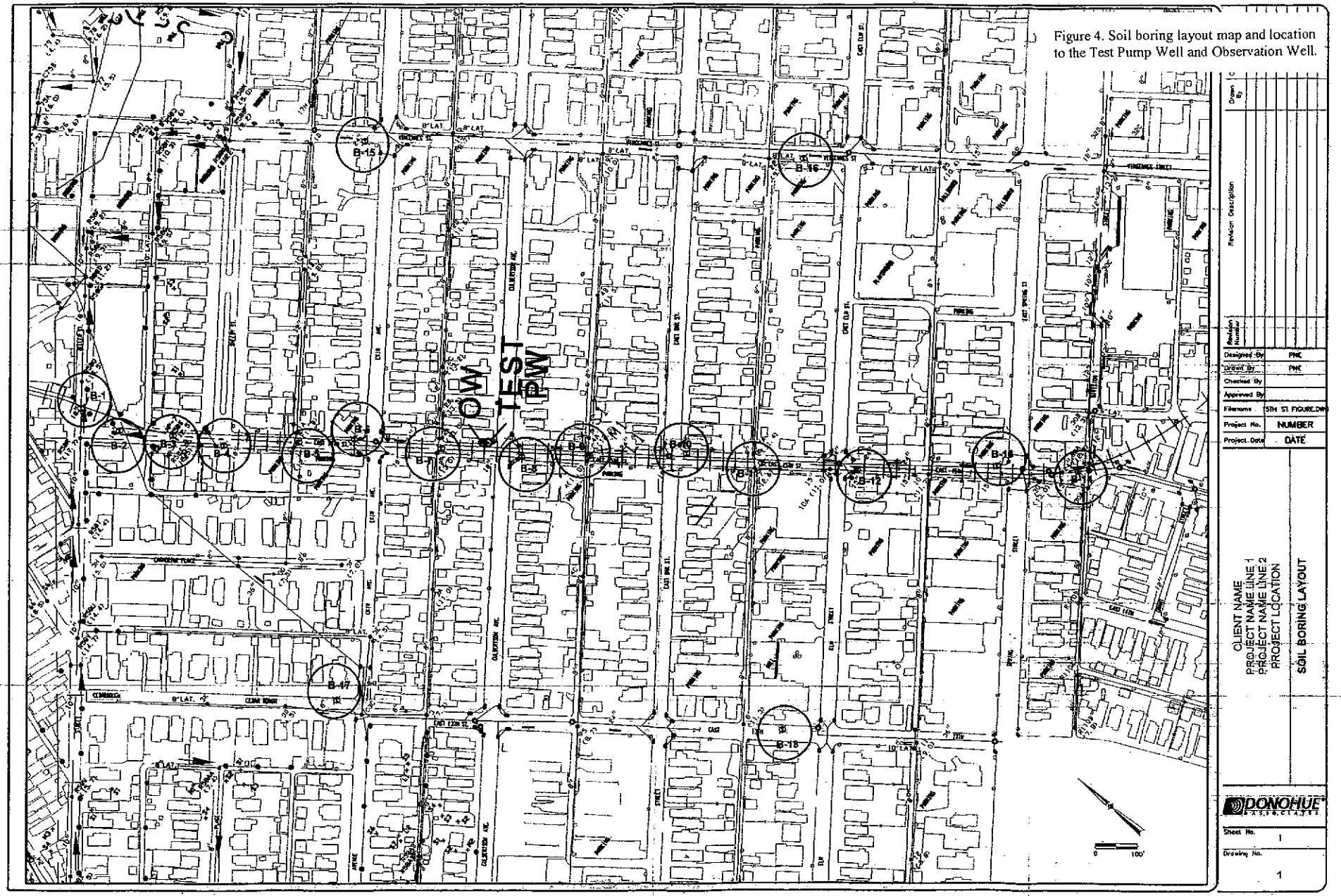
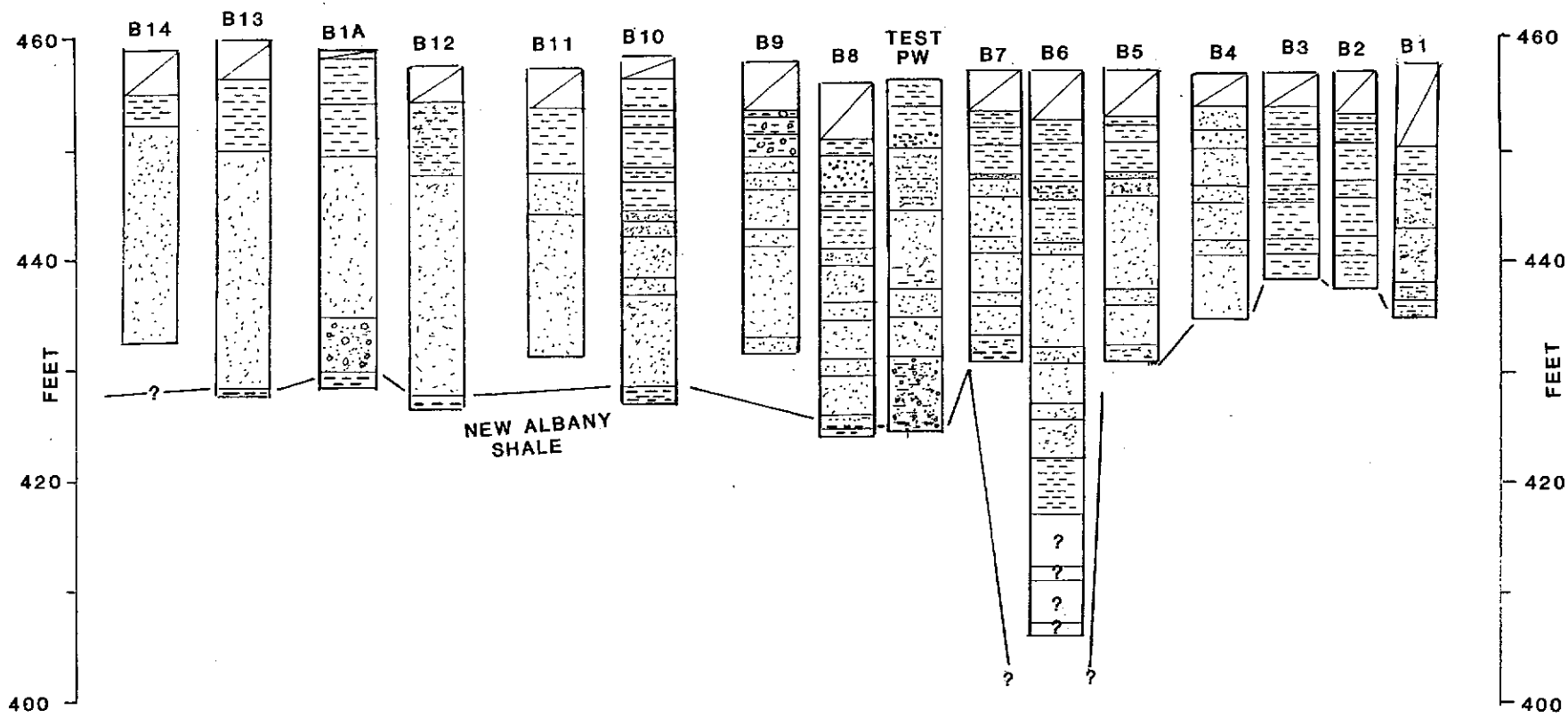


Figure 4. Soil boring layout map and location to the Test Pump Well and Observation Well.

Figure 5. Soil boring lithologic strip logs along 15th Street, New Albany, Indiana.



became smeared with unexpected clay till when the augers were pulled back to expose the screen to the formation. The well screen was pulled out of the clay till up into fine sand located higher in the formation. The well required more development time than was reasonably expected under more favorable circumstances. The well would not pump as much as was initially expected. Enough water was extracted to stress the aquifer in the vicinity of the observation well and drawdowns responded adequately during the aquifer test in the observation well.

For the aquifer pump test, a submersible pump was installed into the 5¼-inch diameter well. During the aquifer pump test, water level readings were taken with an electric water sensing measuring tape (M-scope). Based on preliminary pumping and development the day before the test, it was determined the well could be pumped at 11.16 gallons per minute without breaking suction. The well was pumped for 240 minutes, and drawdown measurements were made in each well. After which the aquifer was allowed to recover and measurements were made in each well for nearly the same period of time (210 minutes). The pump test was needed to derive aquifer coefficients of Transmissivity (T) and Storage Coefficient (S). The specific capacity (Q/s) of the pumping well was also determined. Aquifer pump tests are site specific and represent an average approximation of aquifer coefficients.

Furthermore, the aquifer is under pressure and the piezometric water surface exhibits leaky artesian conditions.

Most meaningful aquifer coefficients are extracted from time-drawdown and residual drawdown semi-log graphs based on water level measurements made in one observation well (see Appendix, Aquifer Pump Test Analysis).

Jacob's non-equilibrium formulas are used to determine the Transmissivity (T) and Storage Coefficient (S) values of the aquifer. Time-drawdown slope line prior to the recharge event (late in the pump test) gives a T value of 14731 gpd/ft and a Storage Coefficient (S) value of 0.01.

Once the pumping well was shut down, residual-drawdown data was collected in both wells (see Appendix, Aquifer Pump Test Analysis). The pumping well recovered in 7-minutes, and after 210-minutes yielded a positive water level of 0.07-feet above the original static water level. This is small and is more than likely a response to a low-pressure front moving into southern Indiana at that time. The observation well recovered back to static water level at 180-minutes into the recovery. Residual-drawdown data from an observation well is more exact than data measurements from the same well during pumping for a number of physical reasons. Mathematical coefficients are more representative of the aquifer, especially Transmissivity. A higher T value of 16368 gpd/ft is in reasonable agreement with time-drawdown T value, or within 11%.

Interpretation of the residual-drawdown graph indicates the graph drawdown line is displaced to the right and so does not represent ideal aquifer conditions associated with a homogeneous aquifer. These aquifer systems are very heterogeneous.

In the pumped well there is 10.9-feet of available drawdown. The well was pumped at 11.16 gpm and produced a Specific Capacity (Q/s) of 1.38 gpm/ft. The maximum yield down to the top of the screen is 15.04 gpm. Or, if we were able to pump to the bottom of the screen, a well yield of 21.94 gpm would be possible. The well is not very efficient and would under other circumstances require a considerable effort at development. Drawdown around the pumping well was very steep VS shallow around the

observation well. Such a condition indicates the pumped well is inefficient. Furthermore, rapid recovery of the pumping well is consistent with a well screen plugged up with clay. Time restraints and the practicality of expediting the work prevented the utility of moving the aquifer test to another site and drilling new wells. We were not interested in producing a pumping well of high efficiency, rather, the act of stressing the aquifer to produce drawdown at a distance with a known pumping rate is all that was needed for this experiment.

As a cross check for the workability of T value from the residual-drawdown data, a comparison is made to other wells in the area. High yield shallow water wells in this locality can be used to approximate aquifer conditions south of our pump test. Maier (2006) records well yields in the range of 180 gpm. The estimated Specific Capacity (Q/s) is 9 gpm/ft and is based on well depth, estimated screen length, and available drawdown to the top of the screen. We know the saturated thickness (m) of the formation is 20-feet in the area of the Main Street wells. If we used 10-feet of screen and pump to the bottom of the screen which is also the location of bedrock, will give a Specific Capacity (Q/s) of:

$$Q/s = 180/20 = 9 \text{ gpm/ft of drawdown}$$

Determining Transmissivity for the leaky artesian case, gives:

$$T = 1750\ Q/s = (1750)(9) = 15750 \text{ gpd/ft}$$

This value is within 4% of the residual-drawdown value from the aquifer test, and gives us confidence as to its workability in this locality.

Consider crosschecking with calculating the Theoretical Specific Capacity (Q/s_t) of a 12-inch diameter well in this setting. These calculations as always are for 100% efficient wells in a homogeneous aquifer along with a whole raft of idealized conditions. Using a rewritten Jacob's equation for one day time:

$$Q/s_t = T/264 \log (r^2\ S/0.3\ T\ t)$$

$$Q/s_t = 16368/264 \log [(0.5)^2\ (0.01)/(0.3)(16368)\ (1) = 9.85 \text{ gpm/ft}$$

Calculated T and S values for a 12 inch well produced a Q/s_t of 9.85 gpm/ft and is close to our estimate of the Main Street wells.

DEWATERING WELL NETWORK

A dewatering network is divided into two sets based upon the aquifer test and extrapolations from neighboring high yield water wells.

Working Storage Coefficient (S) for all sites is 0.01.

Working T value of 16368 gpd/ft for everything south of Shelby Street.

Formation degenerates into clay-silts north of Shelby Street to Beeler Street and may not require a dewatering well network. Sump pumps might be used in extracting excess water in the excavation.

Aquifer coefficients from the aquifer analysis are used to calculate the total discharge rate (Q) needed to keep water levels below the excavation floor. Extraction rates are commonly estimated with the Dupuit-Forchheimer equation:

$$Q = 2[x\ K\ (H^2 - h^2)/2880R] + K\ (H^2 - h^2)/1055\ \log R/r_e$$

Rewritten substitution is needed to take into consideration the width of the excavation:
$$Q = 2[x\ K\ (H^2 - h^2)/2880R] + K\ (H^2 - h^2)/1055\ \log R/b/2$$

Where:
Q= Yield needed to extract from the excavation, gpm.
K = Hydraulic Conductivity, gpd/ft^2.
R = Radius cone of depression, feet.
r_e = Radius of equivalent circular area, feet.
H = Initial saturated thickness, feet.
h = Saturated thickness of aquifer after water level has been lowered, feet.
x = Length of excavation, feet.
b = Width of excavation, feet.

Note that the dewatering pump is at the edge of the excavation.

Lowering the piezometric surface for one day in well B12 to 7.5 feet would require an extraction rate of:

$$Q = Q/s_t * s$$

$$Q = 9.85 * 7.5 = 73.88 \text{ gpm extraction rate}$$

Sample calculations are given in the Appendix (Dewatering Well Design Calculations) for the Dupuit-Forchheimer equation. Found that 50 gpm spread over 1 day and 2 day time periods, with 80 feet well centers, and 40 feet midway points (asterisk *) works best. Four wells produce the following drawdowns. Drawdowns were calculated using the Jacob's non-equilibrium formula.

TABLE 1
Cumulative Drawdowns in extraction wells

1-DAY

1	*	**2**	*	**3**	*	**4**	**Well Locations**
5.07		5.07		5.07		5.07	
0	2	1.52	1.23	1.03	.87	.75	
.75	.87	1.03	1.23	1.52	2	0	
1.52	2	0	2	1.52	1.23	1.03	
1.03	1.23	1.52	2	0	2	1.52	
8.37	**6.1**	**9.14**	**6.46**	**9.14**	**6.1**	**8.37**	**Cumulative Drawdown**

2-DAY

1	*	**2**	*	**3**	*	**4**	**Well Locations**
5.31		5.31		5.31		5.31	
0	2.24	1.76	1.47	1.27	1.12	.99	
.99	1.12	1.27	1.47	1.76	2.24	0	
1.76	2.24	0	2.24	1.76	1.47	1.27	
1.27	1.47	1.76	2.24	0	2.24	1.76	
9.33	**7.07**	**10.1**	**7.42**	**10.1**	**7.07**	**9.33**	**Cumulative Drawdown**

The two-day drawdowns in the excavation will aerate the top of the screens in well nos. 2 and 3. During pumping, wells will have to be valve down to better balance total extraction rates.

Dewatering well construction could be envisioned as a 6 X 12 inch gravel pack well with 10 feet of screen of small slot size. The well is drilled in most cases to the bottom of the unconsolidated formation, or approximately 30 feet to the top of the New Albany Shale. One should be on alert that the formation contains lacustrine backwater deposits and can change its character horizontally and vertically. Presence of clay in the formation will dramatically alter ground water extraction rates in individual wells. The contractor should have the pumping capability of at least 100 gpm or greater per well. Well yields are suspected to increase from Culbertson Avenue toward Spring streets. Water level depth will change seasonally, high in the fall and winter and declines during the spring and summer. Calculations in this report are for late summer conditions.

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Rorabaugh, M. I.; F. F. Schrader, and L. B. Laird, 1953, Water Resources of the Louisville area, Kentucky and Indiana. United States Geological Survey, Circular 276.

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Well No. B1

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: July 3, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 23.08 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 458 ft
Water Level: 14 ft on drill rod After Drilling: 2 ft 2 hours later: NA
Date Measured: July 3, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B2

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: July 9, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 20 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 457.2 ft
Water Level: 16 ft on drill rod After Drilling: 12 ft 3 hours later: 10 ft
Date Measured: July9, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B3

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: July 9, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 18.42 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 457 ft
Water Level: 15 ft on drill rod After Drilling: 8 ft 2 hours later: 8 ft
Date Measured: July 9, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B4

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: July 9, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None
Use of Well: Test boring to assess character of formation
Well Depth: 22.25 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 457 ft
Water Level: 15 ft on drill rod After Drilling: 4 ft 2 hours later: 4 ft
Date Measured: July 9, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B5

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: July 3, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 26.5 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 457 ft
Water Level: 10 ft on drill rod After Drilling: 8 ft 2 hours later: NA
Date Measured: July 3, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B6

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: July 9, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 51.5 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 457 ft
Water Level: 15 ft on drill rod After Drilling: 10 ft 2 hours later: 8 ft
Date Measured: July 9, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B7

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: July 3, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 25.5 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 457 ft
Water Level: 4 ft on drill rod After Drilling: 2 ft 2 hours later: NA
Date Measured: July 3, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B8

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: July 10, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 32 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 456 ft
Water Level: 15 ft on drill rod After Drilling: 8 ft 2 hours later: 8 ft
Date Measured: July 10, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B9

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: July 3, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 26.5 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 458 ft
Water Level: 20 ft on drill rod After Drilling: 12 ft 2 hours later: NA
Date Measured: July 3, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B10

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: July 10, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 31.67 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 458.6 ft
Water Level: 15 ft on drill rod After Drilling: 10 ft 2 hours later: 10 ft
Date Measured: July 10, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B11

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: July 2, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 26.5 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 457.6 ft
Water Level: 13 ft on drill rod After Drilling: 6 ft 2 hours later: NA
Date Measured: July 2, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin outwash aquifer subsystem

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B12

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: July 10, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 31 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 457.5 ft
Water Level: 15 ft on drill rod After Drilling: 10 ft 2 hours later: 10 ft
Date Measured: July 10, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin outwash aquifer subsystem

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B13

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: July 2, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 32.25 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 460 ft
Water Level: 8 ft on drill rod After Drilling: 6 ft 2 hours later: NA
Date Measured: July 2, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin outwash aquifer subsystem

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B14

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: July 2, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 26.5 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 459 ft
Water Level: 6 ft on drill rod After Drilling: 3 ft 2 hours later: NA
Date Measured: July 2, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin outwash aquifer subsystem

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B15

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: June 28, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 15.42 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 458 ft
Water Level: 8 ft on drill rod After Drilling: NA 2 hours later: NA
Date Measured: June 28, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

See Greenbaum and Associates drilling schedule.

Well No. B16

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: June 28, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 34.17 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 462 ft
Water Level: 18 ft on drill rod After Drilling: NA 2 hours later: NA
Date Measured: June 28, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

See Greenbaum and Associates drilling schedule.
NOTE: Hole collapsed below 18 ft

Well No. B17

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: June 29, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 27.58 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 456 ft
Water Level: 15 ft on drill rod After Drilling: 8 ft 2 hours later: NA
Date Measured: June 29, 2007
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

See Greenbaum and Associates drilling schedule.
NOTE: Hole collapsed below 9.58 ft

Well No. B18

WELL SCHEDULE

Recorded by: Mike Wells **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: June 29, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 33.17 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 458.6 ft
Water Level: 14.17 ft on drill rod After Drilling: 8 ft 2 hours later: NA
Date Measured:
Topo of well site: thalweg tributary to Falling Run
Major Aquifer: Wisconsin outwash aquifer subsystem

WELL LOG

See Greenbaum and Associates drilling schedule.
NOTE: Sand heaved into augers at 25 ft; hole collapsed below 11 ft

Well No. B1A

WELL SCHEDULE

Recorded by: T. Powers **Source of Data**: Greenbaum Associates, Inc. drilling log
Date: February 13, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Use of Water: None **Use of Well:** Test boring to assess character of formation
Well Depth: 31.08 ft **Diameter Well:** 8 in **Screen:** NA **Gravel Pack:** NA
Method Drilled: Auger (8 inch), Core Barrel (2 ½ inch)
Usable Depth: NA **Casing:** NA **Type:** NA **Dia.:** 8 inch
Surface Casing: None **Screen Length:** NA
Driller: Mike Wells: Greenbaum Associates, Inc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 458.8 ft
Water Level: 15 ft on drill rod After Drilling: NA 2 hours later: NA
Date Measured: February 13, 2007 **Topo of well site**: thalweg tributary to Falling Run
Major Aquifer: Wisconsin outwash aquifer subsystem

WELL LOG

See Greenbaum and Associates drilling schedule in report dated March 1, 2007

Well No. Test Pump Well

WELL SCHEDULE

Recorded by: Angelo I. George **Source of Data**: On-site
Date: August 16, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Ownership: City of New Albany Government
Use of Water: None
Use of Well: Test pump well for aquifer analysis
Well Depth: 32.5 feet **Diameter Well:** 5 ¼ inch **Screen:** 4 feet stainless steel, 15 slot
Casing Stick Up: 0.95 feet above land surface
Gravel Pack: NA
Method Drilled: Auger (10 ½ inch)
Usable Depth: 25.5 feet **Casing:** Steel **Type:** NA **Dia.:** 5 ¼ inch
Surface Casing: None **Screen Length:** 4 feet
Driller: Dwane Reynolds of National Water Services, Llc.
Lift: Submersible Pump **Power:** Electric
Description Measuring Point: Land surface Alt. 458 feet
Water Level: 10.92 feet BLS
Date Measured: August 20, 2007 **Topo of well site**: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

Samples described based on auger return to surface.

0-2.5	Medium orange clay soil.
2.5-6.5	Olive clay with basal 1 feet of gravel.
6.5-12	Brown silty clay; wet at 12 feet.
12-19.5	No return at 17 feet, suspect very fine saturated sand. Real fine brown ropy sand below 17 feet.
19.5-22	Fine brown sand.
22-25	Soupy fine brown sand.
25-32.5	7 feet of blue gray till (mixture of clay, sand, and gravel). New Albany Shale chips in bottom of return samples.

Well No. Observation Well

WELL SCHEDULE

Recorded by: Angelo I. George **Source of Data**: On-site
Date: August 17, 2007
State: Indiana **County:** Floyd **Quadrangle:** New Albany
Owner or Name: City of New Albany Government
Ownership: City of New Albany Government
Use of Water: None
Use of Well: Observation well for aquifer analysis
Well Depth: 24 feet **Diameter Well:** 2 ¼ inch **Screen:** 5 feet, 10 slot
Casing Stick Up: 0.85 feet
Gravel Pack: NA
Method Drilled: Auger (4 ¼ inch)
Usable Depth: 24 feet **Casing:** PVC **Type:** NA **Dia.:** 2 ¼ inch
Surface Casing: None **Screen Length:** 5 feet
Driller: Dwane Reynolds of National Water Services, Llc.
Lift: None **Power:** None
Description Measuring Point: Land surface Alt. 458 feet
Water Level: 10.92 feet BLS
Date Measured: August 20, 2007 **Topo of well site**: thalweg tributary to Falling Run
Major Aquifer: Wisconsin lacustrine and backwater aquifer system

WELL LOG

See Test Pump Well

WATER WELL SCHEDULE OF BASIC INFORMATION FOR AQUIFER TEST

WELL FIELD: NA **WELL No.** Test Pump Well
ADDRESS OF OWNER: City of New Albany, Government

LOCATION: Northeast corner of 15th Street and Culbertson Avenue, New Albany, Indiana
DATE DRILLED: August 16, 2007 **METHOD:** Auger
CONTRACTOR: National Water Services, Llc., Paoli, Indiana

WELL DEPTH: 32.5 feet **FORMATION DEPTH:** 25.5 feet
SCREEN LENGTH: 4 feet **SLOT SIZE:** 15 **TYPE:** Continuous-slot
DIAMETER OF SCREEN: 5 ¼ inch **DIAMETER OF HOLE:** 10.5 inch
GRAVEL PACK: NA
PUMPING RATE: 11.16 gpm **SPECIFIC CAPACITY:** 1.38 gpm/ft
Measuring Point Stick Up: 0.95 feet

NOTE: Hole collapsed around screen and casing when augers were pulled back.

PUMPING WELL TEST: **DATE:** August 20, 2007
Drawdown measurements made at to of casing.

Date	Rate Gpm	Duration Minutes	Static WL	Pumping WL	Drawdown Ft	Specific Capacity Gpm/ft
		-1	12.0	0	0	
	11.16	0		20.8	8.8	
		1/2				
		1				
		2				
		3		19.92	7.92	
		4		19.83	7.83	
		5		19.88	7.88	
		6		19.94	7.94	
		7		19.98	7.98	
		8		19.98	7.98	
		9		19.96	7.96	
		10		19.97	7.97	
		15		20.0	8.0	
		20		20.0	8.0	
		25		20.01	8.01	
		30		20.02	8.02	

		45		20.04	8.04	
		60		20.04	8.04	
		90		20.04	8.04	
		120		20.04	8.04	
		150		20.06	8.06	
		180		20.1	8.10	
		210		20.06	8.06	
		240		20.10	8.10	1.38
		t Minutes	**t' Minutes**		**PUMP OFF**	
		240.5	1/2			
		241	1	13.66	1.66	
		242	2	12.38	.38	
		243	3	12.10	.10	
		244	4	12.06	.06	
		245	5	12.03	.03	
		246	6	12.01	.01	
		247	7	12.00	0.0	
		248	8	12.0	0.0	
		249	9	11.99	+0.01	
		250	10	11.99	+0.01	
		255	15	11.98	+0.02	
		260	20	11.98	+0.02	
		265	25	11.98	+0.02	
		270	30	11.96	+0.04	
		285	45	11.95	+0.05	
		300	60	11.95	+0.05	
		330	90	11.95	+0.05	
		360	120	11.94	+0.06	
		390	150	11.94	+0.06	
		420	180	11.93	+0.07	
		450	210	11.93	+0.07	

NO. OF OBSERVATION WELLS: 1
I.D. OF OBSERVATION WELLS: Observation Well

WATER WELL SCHEDULE OF BASIC INFORMATION FOR AQUIFER TEST

WELL FIELD: NA **WELL No.** Observation Well
ADDRESS OF OWNER: City of New Albany, Government

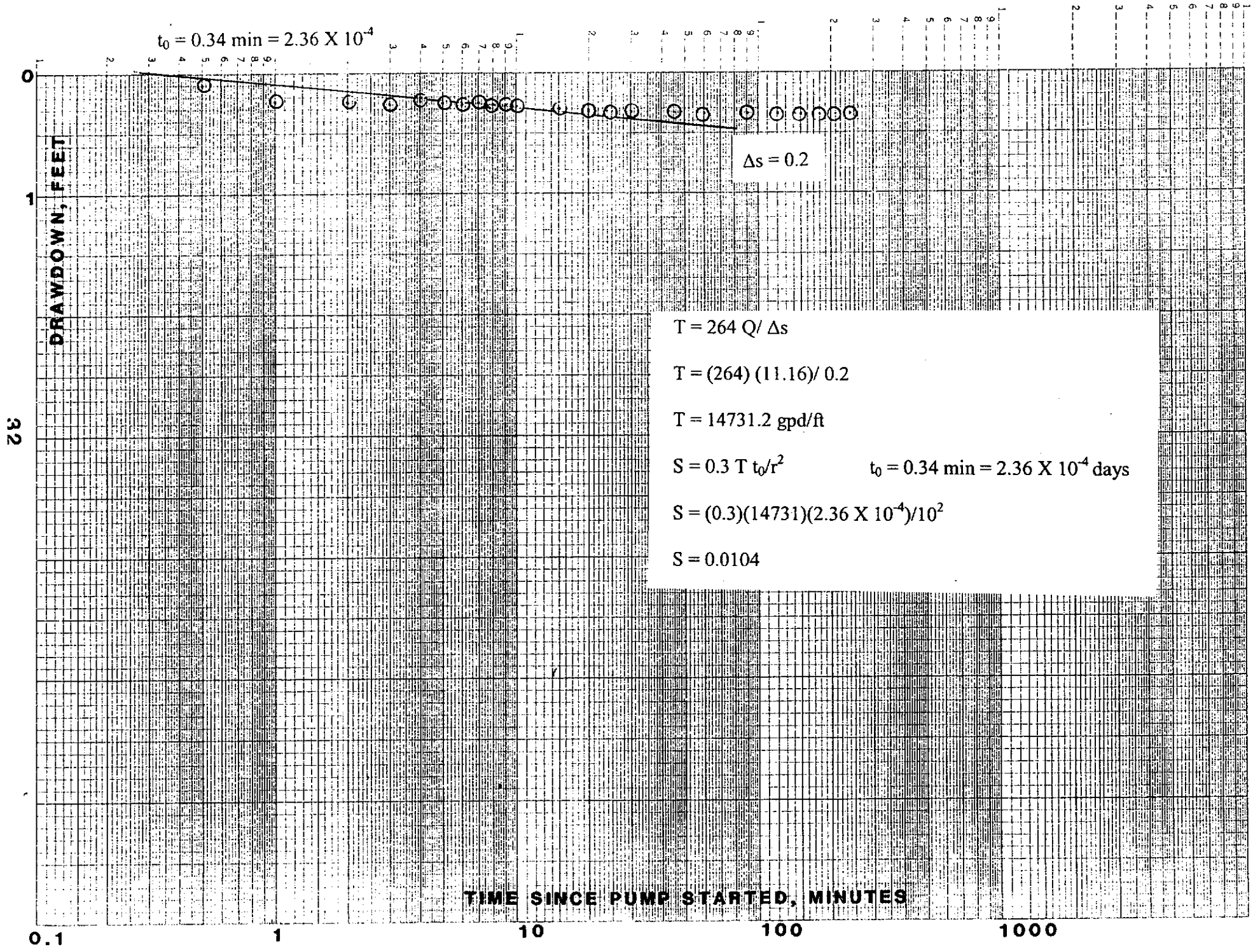
LOCATION: Northeast corner of 15th Street and Culbertson Avenue, New Albany, Indiana
DATE DRILLED: August 17, 2007 **METHOD:** Auger
CONTRACTOR: National Water Services, Llc., Paoli, Indiana

WELL DEPTH: 24 feet **FORMATION DEPTH:** 24 feet
SCREEN LENGTH: 5 feet **SLOT SIZE:** 10 **TYPE:** PVC slotted
DIAMETER OF SCREEN: 2¼ inch **DIAMETER OF HOLE:** 4 ¼ inch
GRAVEL PACK: NA
PUMPING RATE: 11.16 gpm **SPECIFIC CAPACITY:** 1.38 gpm/ft
Measuring Point Stick Up: 0.85 feet
NOTE: Hole collapsed around screen and casing when augers were pulled back.

PUMPING WELL TEST: **DATE:** August 20, 2007
OBSERVATION WELL DRAWDOWN DATA:
Drawdown measurements made at top of casing.

Date	t Minutes	t' Minutes	Static WL	Pumping WL	Drawdown Ft	
8-20-2007						
	-1		11.95	0	0	
	0		11.95	0	0	
	½			12.05	.1	
	1			12.18	.23	
	2			12.2	.25	
	3			12.23	.28	
	4			12.19	.24	
	5			12.21	.26	
	6			12.23	.28	
	7			12.2	.25	
	8			12.22	.27	
	9			12.23	.28	
	10			12.24	.29	
	15			12.25	.3	

	20			12.26	.31	
	25			12.27	.32	
	30			12.27	.32	
	45			12.28	.33	
	60			12.285	.335	
	90			12.28	.33	
	120			12.29	.34	
	150			12.3	.35	
	180			12.3	.35	
	210			12.3	.35	
	240			12.3	.35	
			t/t'			**PUMP OFF**
	240.5	1/2	481	12.28	.33	
	241	1	241	12.156	.206	
	242	2	121	12.12	.17	
	243	3	81	12.09	.14	
	244	4	61	12.07	.12	
	245	5	49	12.05	.10	
	246	6	41	12.02	.07	
	247	7	35.28	12.03	.08	
	248	8	31	12.02	.07	
	249	9	27.67	12.02	.07	
	250	10	25	12.01	.06	
	255	15	17	12.0	.05	
	260	20	13	12.0	.05	
	265	25	10.6	12.0	.05	
	270	30	9	11.99	.04	
	285	45	6.33	11.98	.03	
	300	60	5	11.98	.03	
	330	90	3.66	11.97	.02	
	360	120	3	11.97	.02	
	390	150	2.6	11.97	.02	
	420	180	2.33	11.95	.00	
	450	210	2.14	11.95	.00	



$T = 264\ Q/\ \Delta s$

$T = (264)\ (11.16)/\ 0.2$

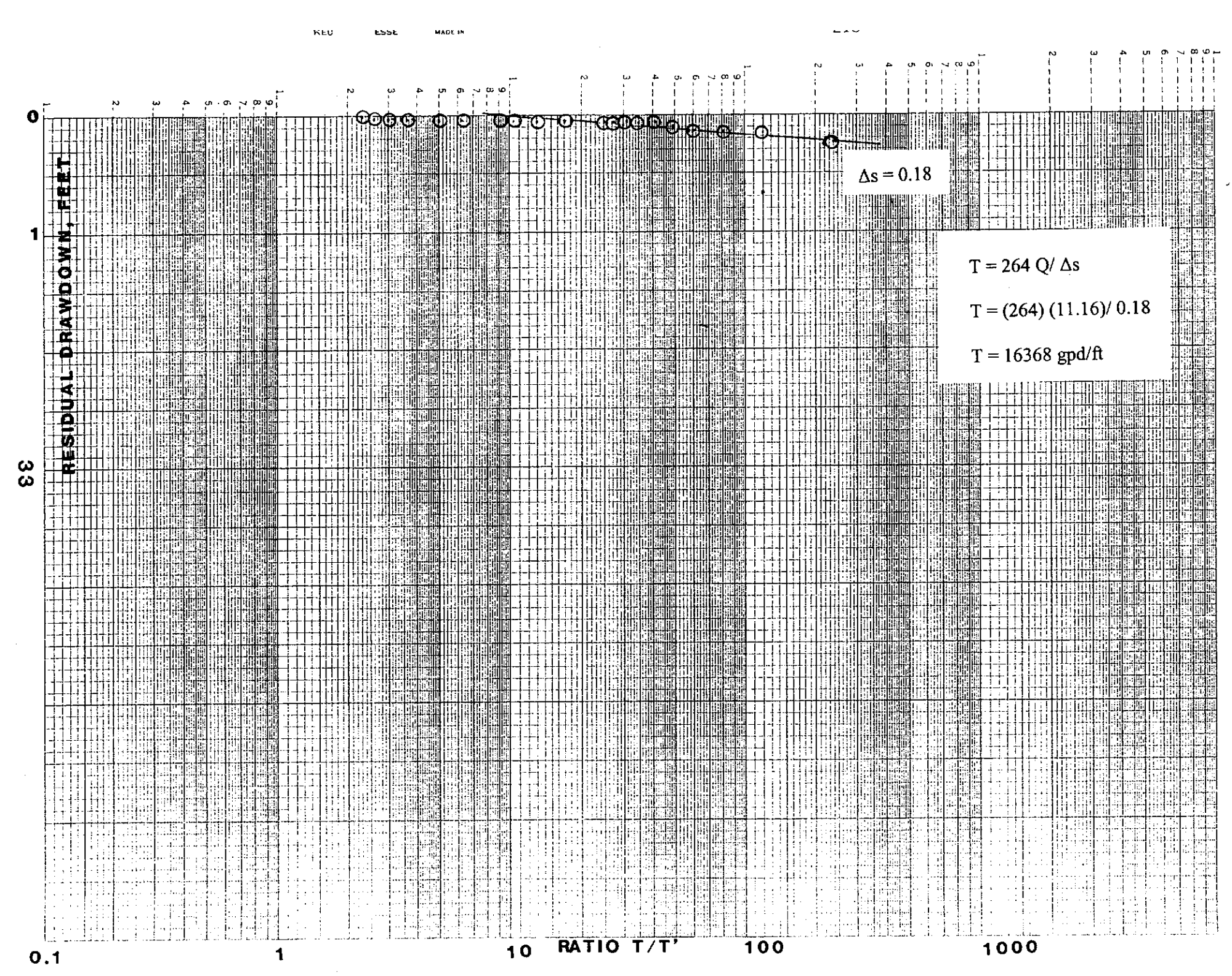
$T = 14731.2$ gpd/ft

$S = 0.3\ T\ t_0/r^2$ $\qquad t_0 = 0.34$ min $= 2.36 \times 10^{-4}$ days

$S = (0.3)(14731)(2.36 \times 10^{-4})/10^2$

$S = 0.0104$

32


RESIDUAL DRAWDOWN, FEET
0
1
33
0.1
1
10
RATIO T/T'
100
1000
Δs = 0.18
T = 264 Q/ Δs
T = (264) (11.16)/ 0.18
T = 16368 gpd/ft

Use B12 locality as an average example.
What we know in general for the B12 locality.
Trench excavation of 350 feet is about the length of a city block.
The goal is to dewater a trench 350 ft X 4 ft to a depth of 17 ft below land surface.
Area to be determined: 350 X 4 = 1400 ft^2.
Assume leaky artesian conditions.
Static Water Level: 10 ft estimated during late summer. Expect higher static level during winter.
Transmissivity: 16368 gpd/ft
Storage Coefficient: 0.01
Assume 10 feet of well screen for all wells.
Total available drawdown to the top of the screen is 10 feet.

Imagine a circle in the middle of the trench excavation with a well in its center. Radius of the circle is calculated as:

$$r_e = \sqrt{ab}/\pi = \sqrt{(350)(4)}/\pi = 11.91 \text{ ft}$$

Value does not work well for line trench excavations, but nice to know anyway. It will give a higher quantity of water removed.

Calculate R radius of cone of depression:

$$R = 0.3\ T\ t/S = (0.3)(16368)(1)/0.01 = 700.74 \text{ ft}$$

Calculate Hydraulic Conductivity:

$$K = T/m = 16368/20 = 818.40 \text{ gpd/ft}^2$$

Total yield (Q) extraction rate using dewatering equation:

$$Q = 2[x\ K\ (H^2 - h^2)/2880R] + K\ (H^2 - h^2)/1055 \log R/b/2$$

$$Q = [350)(818.4)(20^2 - 13^2)/(2880)(700.74)] + (818.4)(20^2 - 13^2)/1055 \log (700.7/4/2)$$

$$Q = 136 \text{ gpm}$$

Insurance estimate by 25% gives:
(136)(.25) = 34 + 136 = 190 gpm
Four (4) wells yield 47.5 gpm/well

The next task is to calculate the combined drawdown interference effects from the four wells pumping simultaneously. Use Jacob's non-equilibrium equation to calculate well interference:

$$s = 264\ Q/T\ \log_{10}\ (0.3\ T\ t/r^2\ S)$$

Numbers were evaluated for one and two days of continuous pumping and are found as Table 1 in the body of the report.